AGRICULTURAL
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A Study of the Impact of No-Till on

TRACTOR FUEL COST

VS

CROP RETURNS

As affected by Various No-Till
Planter Modifications

Report No. 89-1504 February, 1989

This demonstration/evaluation project was partially funded by the Ontario Ministry of Energy and managed by the Agricultural Energy Centre of the Ministry of Agricultural and Food.

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SUMMARY

Fuel use as a factor of crop production costs is a useful measure of efficiency in the food production system. Tillage for crops is a heavy user of fuel. The technology is generally available to make corn and soybean production a practical option without primary tillage.

'No-Till' is such an option. To fine tune the system, No-Till planter attachments were evaluated for effect. Plant stand and crop yield were improved when a 20 cm wide strip was cleared of crop residue when corn followed corn. A planter attachment combination was selected which tilled a band of soil 8 cm wide and 15 cm deep - thus ensuring good seed and fertilizer placement. Varying amounts of tillage affected corn growth rate, but had insignificant effect on plant developement or crop yield in trials where the balance of the crop production technology package was selected from the best currently available.

With the use of 'Conventional Tillage' to provide benchmark data, No-Till corn and soy crop yields and production costs (up to harvest), were tabulated through 1984, 1985 and 1986. A sincere effort was made to use practical crop production procedures which suited both systems.

Results indicate herbicide, fertilizer, seed and other crop costs to be similar for both Conventional-Till and No-Till. Labour cost for No-Till was 45% of that for Conventional-Till, while machine overhead and maintenance cost was 48%.Average No-Till fuel use for corn and soys was 4.68 Litres/acre versus 14.76 L/ac for Conventional-Till.

Of particular interest to a conservation conscious society is that $1.00 worth of fuel produced $51.71 worth of Conventional-Till corn/soys and $170.21 worth of No-Till corn/soys, - an efficiency improvement of more than three times.

ACKNOWLEDGMENTS

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Staff of the Huron Soil and Water Conservation District, the Maitland Valley Conservation Authority, the Ausable-Bayfield Conservation Authority, and Pioneer Hybrid Ltd. were most helpful in monitoring effect and measuring crop yield.

Also much appreciated assistance with this study came from - Tom Lobb, Kevin McKague, and, particularly, Jane Sadler-Richards. Special thanks to these individuals.

The support and interest of my wife, Alison, and my family has made it possible to bring this study to a useful conclusion.

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INTRODUCTION

Careful use of soil and efficient use of fuel is essential to sustain profitable crop production. No crop production system has greater potential to conserve both soil and fuel than does No-Till.

Evaluation of the merits of No-Till in the past have generally not focused on the integration of best technologies as suited to the system. Much of the necessary technology is available, however one area where a gap has continued to exist is in planter modification. Does tillage in a band along the row area by planter-mounted, non-powered equipment, increase crop yield? If so, how much row tillage is required? Is there a cost/benefit? It is therefore, necessary to extend the No-Till technology so that the system may be evaluated fairly.

No-Till food production efficiency must, in the long run, be a matter of interest. A useful way to measure this is simply to compare the dollars worth of food produced relative to one dollars worth of fuel input. "Tractor Fuel Costs vs Crop Returns" is intended to provide such a measurement. To establish the No-Till (N-T) relative production efficiency, it is compared with Conventional-Till (C-T).

Definition - Clarification

'No-Till' is a Trademark of the Allis-Chalmers Corp. The term is now so loosely used that it has been applied to almost every cropping system that does not include primary tillage.

For this study 'No-Till' refers to planting seeds into a strip of soil from which all bulky crop residue has been removed, and which has been treated with planter-mounted passive tillage equipment. This system should not be confused with Zero-Tillage (now sometimes also referred to as 'No-Till'). Zero-tillage has been utilized to minimize residue and soil disturbance where that is considered important.

"Conventional-Till", in this study, refers to the conventional practice of moldboard plowing followed by cultivating, discing and/or packing, as applied at the crop site for comparison purposes.

OBJECTIVES

1. To select, from the options compared, the most cost effective and practical No-Till planter set-up.

2. With the benefit of the preferred No-Till planter set-up, to investigate tractor fuel use/cost as a factor of crop returns. Comparisons made with Conventional-Till crop data should give the study economic relevance.

METHODS and MATERIALS

The study period included the 1984-1985-1986 crop seasons. Crop production practices for both No-Till and Conventional-Till on the study sites are intended to maximize profitability for each system. Progressive system improvement insured that the study was not locked into the use of a production component not practical during the study or beyond its conclusion (ie. planter set-up).

A. Planter Modification Evaluation - Study "A"

To ensure that the Fuel Use vs Crop Returns study provided valid information, the planter performance component of the No-Till system was kept as nearly as possible at the same level as that used for Conventional•Till. Study "A" evaluated the planter set-ups chosen and designated a preference.

The planter used was a White 5100 six-row standard planter, equipped to apply dry fertilizer and insecticide. It was equipped with the manufacturer's standard three-wheel soil-to-seed firming units. With each of the No-Till component packages, additional weight of 75 kg per row was added to insure proper soil penetration.

1) Procedures and Data Collection

(Agronomic procedures are as per Study "B".)

i) Measurements of crop yield and plant populations were determined by staff of the Huron Soil and Water Conservation District (HSWCD).

ii) Planter and component costs are based on 1986 prices.

iii) The planter, and the planter + various component were assigned code numbers which were used to track them throughout the study (Figure 1). Also designated to the code number was a cost price, a work rate and a fuel use requirement as determined from field use checks. (Appendix 4, 5).

iv) For Conventional-Till checks the same planter was used as for No-Till, but it was adjusted to give the same effect as a standard Conventional-Till planter (Code 20 - Figure 1).

v) The planter modifications study has two components:

a) Tillage Effect - to study the effect of the planter mounted tillage attachments (1984). Three planter set-ups were used to evaluate the benefits of passive strip tillage in the No-Till system.

With set-up (23), the objective was to disturb the soil only sufficiently to get good seed to soil contact.
With set-up (22), a 1.2 x 50 cm ripple coulter was added ahead of the fertilizer opener and operated at 15 cm depth.
Set-up (21) was intended to aggressively till. A second 1.2 cm ripple colter was added at the front of the planter and operated at 8 cm depth. Furrowing disks were added ahead of the seed opener.
A Conventional-Till check was included with this study.

Effect was measured by:
- 47 day plant height. (Monitored by Jane Sadler- Richards.)
- crop yield in bu/ac at 15.5% moisture
- harvest moisture content of grain
- final plant population/ac

The study crop was corn. The site provided light soy residue cover (less than 10%), thus interference with planting and crop growth would be minimal. The soil type was sandy clay loam to silty clay loam.

b) Tillage plus Residue Removal - to study the effect of the complete component package (1984, 85, 86). A minimal zero-tillage planter set-up (23) and a No-Till set-up were used to compare in-row tillage plus residue removal in 1984. Because set-up (21) frequently plugged with residue and caused excessive crop row trenching it was replaced by (24) in 1985 and 1986.

Effect was measured by:
- crop yield in bu/ac at 15.5% moisture
- harvest moisture content of the grain
- final plant population - plants/ac

The study crop was corn. The sites for 1984 included residue of soys, barley and corn. The site for 1985 included residues of soys, wheat and corn. The soil type was silty clay loam-sandy clay loam.

B. Tractor Fuel Use/Crop Returns - Study "B"

Crop production costs and returns relative to the tillage system were examined in this study.
Crop costs include time, machine overhead and operation, fuel, seed, fertilizer, herbicide, and other chemicals. Soil loss cost was also documented.

Crop returns were related to fuel use/cost. This study included crop production procedures up to, but not including, harvest. Data is collected from comparisons of No-Till and Conventional-Till corn and soys.
The study period was 1984, 85, 86.

1) Procedures and Data Collection

i) Soil loss estimates were made by staff of the Maitland Valley Conservation Authority. The Universal Soil Loss Equation was used to estimate average site losses, for 1984 and 1985.

ii) The comparison site was planted with the six row x 30" (72 cm) planter as in Study "A". The corn comparisons were harvested with a four row combine. Soys were harvested with a six row (4.57 m) flexible floating cutterbar equipped combine. The harvested rows compared were always matched to include the same planter rows on each side of the site comparisons.

Crop yields were reported in bushels per acre (bu/ac) and adjusted to 15.5% moisture for corn and 14% for soy. Crop yields, grain moistures and plant populations were checked by staff of the Huron Soil and Water Conservation District or Pioneer Hybrid Ltd. Portable "weigh wagons" were supplied by Pioneer, Ausable-Bayfield Conservation Authority, or Centralia College of Agricultural Technology.

iii) Each crop production machine was assigned a code number (Appendix 4) so that work rates and costs could be tracked throughout the study.

iv) Values assigned for the study report included:
Fuel $0.358/L (average throughout the study),
Time $10 /hr
Corn $2.50/bu
Soys $6.50/bu
Topsoil $1.50/MT (Ref. Wall and Driver (1))
Herbicide, fertilizer, seed and other chemical costs were assigned to the sites as of purchase date. (Appendix 6)

v) Fuel and time use was determined in 1984 and rechecked as field conditions changed. This was done for each field operation by checking the time required and the amount used - from the time the equipment left the fuel pump, performed the designated full field operation (as near as possible to 30 acres), and then returned to the fuel pump. The use rates were then assigned to appropriate site comparisons. Calculations were recorded in hours/acre and litres/acre. Work rate in hours/acre for each machine operation, each year, and under varying cropping conditions, was also established by this method.

vi) Machine overhead and maintenance costs were based on the study farm requirements plus custom work which was performed (total approximately 600 acres).

- Replacement value is based on 1986 machinery dealer quotes.
- Annual depreciation for tractor, planter, sprayer, and fertilizer applicator is calculated as 75% of replacement cost/10, other equipment as 90% of cost/15 (Ref. Buth (2).
- Investment cost is 10% of current machine value.
- Housing and insurance is .00667% of replacement cost.
- Repairs and lubrication cost are drawn from the author's farm records for the years 1981 to 1985.

All field data was retained, by the author, on Site and Treatment record sheets which included:

Site Information:

- Soil Type
- Crop History
- Drainage Characteristics
- Site and Treatment Location and Layout
- Treatment Procedures

Treatment Information:

- Tillage - Date, Machines, Machine code, Depth, Work rate, Fuel use rate.
- Planting - Date, Machine, Machine code, Seed rate and variety, Cost, Work rate, Fuel use rate.
- Fertilizer - Date, Application method, Machine code, Analysis, Rate, Cost, Time use, Fuel use rate.
- Pesticide - Date, Application method, Machine code, Material, Rate, Cost, Time use, Fuel use.
- Other materials - Date, Application method, Machine code, Material, Rate, Cost, Time use, Fuel use rate.
- Harvest - Date, Method, Machine code, Grain moisture, Dry grain yield, Time use, Fuel use rate.
- Field Notes - Planting conditions, crop growth, weed control, harvest conditions, etc.

2) Study Site Selection

i) Study sites were located on Lots 18,19,22/Con 15; Lot 26/Con 16; and Lots 76,77/Con. Maitland in Goderich Township, Huron County.

ii) Sites for the comparisons were required to meet four criteria to satisfy the needs of this study. They must:

a) include soils not usually identified as suitable for No-Till
b) include a variety of crop residue situations
c) be of sufficient size to allow accurate machine harvest sampling - greater than 60 meter length x combine header width
d) be site consistent in drainage, soil type, and slope.

iii) For the Fuel Use/ Crop Returns Study, over a three year period 27 sites were established where No-Till crops could be directly compared to Conventional-Till crops - 18 with corn and 9 with soys.

Some of the 27 were actually sub-sites where more than one practice was evaluated on a single location. Each site, for this study, used practices and products which the author would be willing to use for his following year's production.

3) Crop Management

i) Fertility:

- Phosphorus - All requirements were applied with the planter in a band 3-6 cm below and beside the seed. Monomonium phosphate was blended with ammonium nitrate and murate of potash to produce a 12-40-6 ratio, minimum application of 40 kg/acre.
- Potash - The balance of the potash was applied bulk spread to the soil surface prior to planting either in early spring or the fall previous.

- Nitrogen (for corn) - The balance of the nitrogen requirement for corn was side dressed as 28% liquid (U.A.N.) 5-10 cm deep, three to four weeks after planting. Target rate for this study was 65 kg/acre.

ii) Crop Sequence

Sites were:	Corn	follows corn	11 sites
	Corn	soys	3
	Corn	barley ..	3
	Corn	hay sod ..	1
	Soys	follow corn	3 sites
	Soys	soys	6

iii) Weed Control was applied as required with the objective of equal weed control for each system.

iv) Crop Varieties:

- for corn were Pioneer 3975A and Pioneer 3906
- for soys were Pioneer 0877 and Pioneer 1282

v) Seeding Rate:

Plant population target was 26,000 plants per acre for both No-Till and Conventional-Till corn. The same seeding rate (27,500) was used for both systems. Soys were planted at the same rate in both tillage systems.

vi) Other Treatments - Corn rootworm control in the form of Counter @ 4 kg/ac was applied in the seed trench at equal rates for both tillage systems.

Soy innoculant was applied equally as recommended.

RESULTS and DISCUSSION

A. Planter Modification Evaluation - Study "A"

1. Tillage Effect

Three No-Till planter attachment packages are evaluated in this sub-study: codes (23), (22) and (21/24). The Conventional-Till code (20) set-up was compared to provide a benchmark value.

Visual evaluation at planting time noted that set-up (21) was extremely aggressive in all but very dense soil conditions, - to the point that the furrowing disks were tending to form a trench up to 5 cm deep. This problem was overcome when the (24) set-up was adopted as "preferred" in the second year. Set-ups (22) and (23), with progressively fewer attachments, performed progressively less tillage and provided less effective fertilizer placement (a factor which might have been critical on a very dry year).

Plant height measurements (Table 1), taken at 47 days after planting, showed that as the amount of tillage decreased so did plant height; however the plant development was constant.

Harvest time data collected (Table 2) indicated no advantage to increased tillage in terms of crop yield, grain moisture content or final plant population. In spite of the fine textured soil, all of the No-Till set-ups produced crop yields equal to or greater than the Conventional-Till check. Cost-benefit for extra attachments was therefore not realized.

This data was consistent with the findings of Bulman (Ref. 3) and was consistent with observations elsewhere on the study farm, therefore this component of Study "A" was not continued beyond 1984.

2. Tillage plus Residue Removal Effect

The effect of doing some passive in-row tillage with non-powered attachments, in combination with removing residue from the crop row area with set-up (21/24), is reported in Table 3. When compared to set-up (23), which was set-up for minimal soil disturbance, no crop development advantage was identified for extra attachments for corn following soys. The most significant response was noted where corn followed corn. Here a 7.5% plant population improvement accompanied residue removal from the crop row - Table 3.

A crop yield improvement of 2.55% was measured where residue was moved from the crop rows in the corn after corn sequence. Though the increase was small, the positive results are supported by research. Research at the University of Guelph (Van Roestal), and at Iowa State University (Cruse) indicates a significant advantage for removal of residue from the crop row (15 cm or more).

Practical experience on other crop field situations on the study farm has been consistent with the identified research - residue removed from the No-Till crop row area results in crop performance similar to that of Conventional-Till crop. The advantage of residue removal may vary according to residue volume, soil moisture and precipitation, residue type, and insect/slug/ and disease pressure at the site.

Similar evaluations on the study farm have shown the potential to improve crop performance is greater from crop rotation, fertility management, variety selection, cover crop/residue management, and weed control choices, than by planter modification beyond the principles used in set-up (24).

In-row soil erosion has been noted on slopes (less than 10%) with set-up (23), which produces a narrow tilled band, but not with set-up (24) where a wide band (20 cm) of cleared, but undisturbed, soil is exposed.

The author, when producing No-Till soys, has not identified a need to remove residue off the crop row area, thus set-up (22) was used for soybeans. Set-up (24) without furrowing disks gives us set-up (22). Thus furrowing disk wear and horse power requirements are both reduced. (Appendix 5)

Planter set-up (21) resulted in corn and wheat residue catching on the coulter arm, located between the two staggered - but parallel - coulters at the front of the planter. This caused plugging - a mechanical difficulty which could not easily be solved. Set-up (24) therefore replaced set-up (21) beginning in 1985. In making this decision, the 1984 results of the effect of various amounts of tillage (Section 3.A.1) were considered, along with planter set-up costs.

Set-up (24), with an attachment cost of $525 per row, became the preferred method for corn following crops other than soys. Where corn follows soys, and where soys were planted in any crop residue, set-up (22), at $400 per row, was preferred.

These set-ups were used throughout the Fuel Cost vs No- Till Crop Returns study - Study "B".

B. Tractor Fuel Costs vs Crop Returns - Study "B"

This study indicates that for $1.00 worth of tractor fuel, $170.21 worth of corn and soys can be produced, before harvest costs, when the No-Till system is used.

This is 3.29 times more than was produced with $1.00 worth of tractor fuel under conventional tillage (Table 6). A break-down of allocated costs and returns (Table 4) follows.

1. Fuel Use/Cost - only represents a small portion of crop production costs (0.59%). If harvest fuel costs had been included, the No-Till figure would have been increased by 107% and Conventional-Till by 34%. The No-Till system then produces 2.58 times more than Conventional-Till with $1.00 of fuel.

   A fuel use/cost estimate for the production of fertilizer and chemicals was not included as the use rate was relatively constant in this study (Table 4). Also not included in the summary was collected data which indicates that under wet harvest/soil conditions (1985, 1986) combine work rate was reduced and fuel use rate increased by 9% on Conventional-tilled corn and soys as compared to No-Till.

2. Time/Labour Cost - for No-Till was 45% of that required for Conventional-Till, with the greatest reduction in time use coming prior to planting and post harvest.

3. Machine Overhead and Maintenance Cost - for No-Till was 48% of that for Conventional-Till (Table 4 and Appendix 2). The new replacement cost of the equipment for No-Till is 57% of the $135,336 Conventional-Till investment (Table 5). This suggests that the investment in equipment figures which are commonly used do not fully reflect the reduced cost of equipment used in the No-Till production system.

4. Crop Management

   The following guidelines were used for the No-Till vs Conventional-Till system under study, to insure a sound basis for comparison.

i) Crop Sequence may have either positive or negative effects on crop yield. For the purpose of the Fuel Use/Crop Returns study, short crop rotations were used with preference to compatible sequences. Studies have shown this to be important for success with No-Till particularly on fine textured soils, Mannering and Griffiths (6).

ii) Fertility - The fertility program was based on available research, and is further supported by research more recently completed. The program was developed to have adequate plant root access to potash in dense soil conditions and to insure efficient phosphorus use Reid (7). The nitrogen program was intended to minimize potential for volatilization, and, or residue tie-up, Fox and Hoffman (8), along with minimal potential for increased pH levels at the soil surface.

The adopted program has good potential for efficient nutrient use in low fertility soils and in low precipitation seasons. Because the program was considered most efficient under a wide range of conditions and for both N-T and C-T, the same rates and costs applied to both systems.

The decision was made during this project that in future all potash would be applied in the row band in an attempt to lower overall potash rates.

iii) Weed Control requirements are site specific; particularly as applied to different tillage systems. The timing for the most cost effective control varies - therefore herbicide was applied as required with the objective of equal control - for both Conventional and No-Till treatments. Equal control was achieved.

iv) Herbicide Cost - reported in Table 4, indicates a $12.01 advantage to No-Till soys. That cost savings is distorted because of weed control problems associated with producing two successive soy crops. The normal practice on the study farm is to grow soys following corn. Therefore, for the purpose of this study, weed control costs are based only on data collected from soys following corn sites - the advantage then becomes only $2.20 in favour of No-Till. The higher weed control cost resulted from post-emergence treatment of late flushes of weeds in Conventional-Tilled soys.

Average weed control cost for corn and soys is $0.17 higher for Conventional-Till than No-Till (when normal crop sequences are used).

It was noted that some weeds, such as quack grass and field bindweed were more easily controlled in No-Till.

In No-Till preference was to treat emerged weeds whenever possible rather than to treat the soil for anticipated weeds.

v) Crop Varieties/Plant Populations were selected from variety trials on the study farm. Varieties used had produced the highest yields regardless of tillage system. Final plant populations were similar between comparisons in this study and the cost of seed was the same.

vi) Other Chemical Cost - is the same for both tillage systems. The Conventional-Till preferred program for other chemicals was also preferred for No-Till.

5. Soil Loss - data was collected, but not included in the cost calculation because soil losses were averaged over each study site. The loss on average appears very low - close to or below (T) the tolerance soil loss level (Appendix 7).

Within several sites, there are areas with the potential for very high soil loss rates. Calculations would have been more useful if they had included the range of soil loss on each site using the Univeral Soil Loss Equation, Wischmeier and Smith (9).

The result estimates are, however, interesting. When corn was grown, soil losses recorded were three times higher with Conventional-Till than with No-Till. When soys were grown, soil losses were more than five times greater with Conventional-Till.

6. Crop Returns - Average gross returns per acre were $12.41 higher for No-Till corn and soys. This is partially due to a slightly higher No-Till yield for both crops.

Average returns per acre above allocated costs (those costs where tillage influenced variability is usually associated) were $41.09 in favour of No-Till corn and soys when compared to Conventional-Tilled corn and soys. Average soil loss variance between tillage systems increases the advantage to $47.17 for No-Till.

CONCLUSIONS

Tillage by itself may not increase crop yield significantly on medium and fine textured soils. However, residue removal from the crop row does increase plant stand and crop yield when corn follows corn.

The cost/benefit for adding N-T planter attachments ends when good seed and fertilizer placement is achieved and when the immediate crop row area is cleared of old vegetative residue.

The relative benefits of tillage and residue removal from the crop row vs crop sequence effect, nitrogen management, crop variety, stress tolerance, cover crop management, weed control, etc. need to be established to give perspective to the new adopter of No-Till when he/she puts together his/her crop production system.

Crop yields and economic results recorded with the management package used in this study indicate that there is currently available sufficient technology to make No-Till equally as profitable as Conventional-Till, and to do so on a wide range of soil types.

No substantial increase was required in the use of fertilizer, seed or pesticides, thus there is no apparent increase in cost or in risk to the environment as affected by use rates.

Reductions were noted in machinery investment, machine operating costs, and labour time/cost, thus these factors account for the greatest incentive to adopt the No-Till system. Though the cost of fuel used for crop production is small compared to other production costs, the greatest saving with No-Till is for fuel cost relative to the value of crops produced.

It would have been more effective to quantify site specific soil loss cost within a study site so that it could become a part of the cost of crop production in a meaningful way. Averages do not account fully for soil loss effect on the most critical slope positions.

This study suggests that the greatest limiting factor in the adoption of No-Till lies in the interpretation of research and in the transfer of technology and information.

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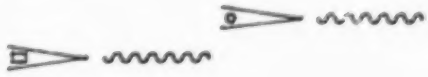
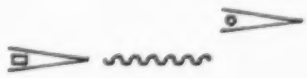
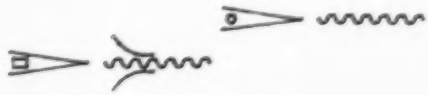
FIGURE # 1

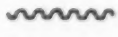
CORN PLANTER ATTACHMENTS EVALUATED FOR NO-TILL

CODE	COST NOTES	ATTACHMENT ARRANGEMENTS
(20)	$00./row Basic planter Conventional Till	
(21)	$716/row Till and clean - aggressive tillage Preferred set-up in 1984	
(22)	$400/row Enhanced tillage set-up Used on soy residue in 1984,85,86	
(23)	$208 /row Minimal tillage Used as a check	
(24)	$525 /row Till and clean - moderate tillage Preferred for corn residue 1985,86.	

ATTACHMENT EXPLANATION

Seed opener
- double disk - 30 cm

Ripple coulter
- 1.2 cm x 45 cm, operates 6 cm deep



Furrowing disks
- 30 cm - notched - 25 cm

Fertilizer opener
- double disk - 30 cm

Ripple coulter
- 1.2 cm x 50 cm - operates 15 cm deep

Ripple coulter
- 1.2 cm x 50 cm - operates 8 cm deep

PLANTER / TILLAGE EFFECT

- on sandy clay loam and silty clay loam soils
- on soybean residue
- study crop was corn
- data reported as per planter set-up

TABLE 1

TILLAGE VS PLANT DEVELOPMENT

1984	47 Day Plant Measurements
C-T (20)	87.7 cm/ 12 leaves
N-T (21)	83.4 cm/ 12 leaves
(22)	74.4 cm/ 11-12 leaves
(23)	69.3 cm/ 12 leaves

TABLE 2

TILLAGE VS HARVEST RESULTS
* Average of two sites 1984/1985

1984/85	Final P.P.A.	Harvest Moisture	Dry Yield
C-T (20)	25725	24.85	138.0
N-T (21) (24)	25375	24.35	141.4
(22)	25625	23.95	138.45
(23)	25725	24.15	139.15

TABLE 3

NO-TILL PLANTER ATTACHMENT EVALUATION
TILLAGE PLUS RESIDUE REMOVAL EFFECT

Study Crop - Corn
Soil Types - Sandy clay loam, silty clay loam
Planter Set-up and Residue Type as designated
Two sites - 1984, 1985

Residue type	Planter set-up	Final P/A	Harvest Moisture	Dry Yield
Soy	(21/24)	25857	24.1	139.0
	(23)	25725	24.15	139.15
Advantage re extra attachments		.5%	0%	0%
Barley/wheat Straw harvested	(21/24)	23775	24.4	133.5
	(23)	24125	24.5	132.15
Advantage re extra attachments		-1.6%	0%	+1%
Corn	(21/24)	24600	23.6	118.9
	(23)	22850	23.2	116.05
Advantage re extra attachments		+7.5%	-2%	+2.5%

TABLE 4

RETURNS TO ALLOCATED COSTS - PER ACRE

Crop Treatment	Time $10/hr	Machine Overhead & maintenance	Fuel Cost (/L)	Seed	Fert.	Other Chem.	Herbic.	Total	Crop Value Costs	Net to allocated
SOYS: 9 comparisons										
N-T	4.56	14.67	1.43	21.62	24.77	.89	36.06	$104.00	247.85	$143.85
C-T	12.07	36.54	5.37	21.62	24.77	.89	48.07	$149.33	227.24	77.89
								Advantage to N-T =		$ 65.96
NB - Soys should normally follow corn in a rotation. On three sites where this was done average herbicide cost was:										
N-T, $35.62 ; C-T, $37.82.										
The more realistic returns to allocated cost is now:										
N-T	4.56	14.67	1.43	21.62	24.77	.89	35.62	$103.56	247.85	$144.29
C-T	12.07	36.54	5.37	21.62	24.77	.89	37.82	$139.05	227.24	88.16
								Adjusted advantage to N-T =		$ 56.13
CORN: (18 comparisons)										
N-T	6.08	19.77	1.92	25.34	74.23	12.23*	20.71	$160.29	324.05	$163.76
C-T	11.73	34.54	5.20	25.34	74.23	12.23*	18.86	$182.14	319.83	137.69
								Advantage to N-T =		$ 26.07
* In a simple rotation with one year of corn, insecticide could be eliminated.										
In a simple rotation, where corn and soys are alternated, average values would be:										
N-T	5.32	17.22	1.68	23.49	49.50	.45	28.17	$125.83	285.95	$160.12
C-T	11.90	35.54	5.29	23.49	49.50	.45	28.34	$154.51	273.54	$119.03
								Rotation advantage to N-T =		$ 41.09

TABLE 5

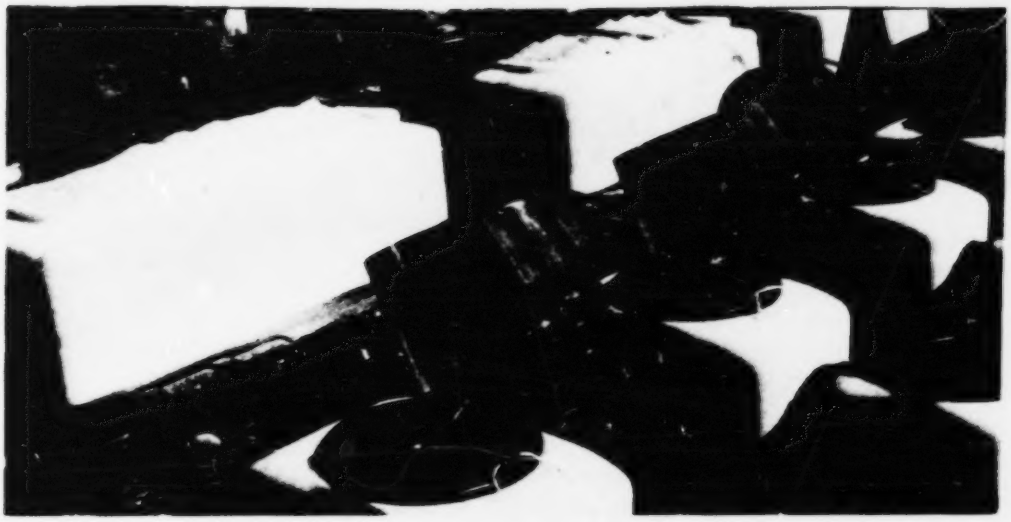
SELECTED TILLAGE SYSTEM COMPARISONS

Fuel Cost /ac: From Table 4	
N-T corn + soys /2 - 4.68 L	$ 1.68
C-T corn + soys /2 - 14.76 L	$ 5.29
Labour Cost / Acre: From Table 4	
N-T corn + soys /2 - .532 hr x $10/hr	$ 5.32
C-T corn + soys /2 - 1.19 hr x $10/hr	$11.90
Machine Costs / acre (Maintenance + Overhead): From Table 4	
N-T corn + soys /2	$17.22
C-T corn + soys /2	$35.54
Machine New Cost / system: From Appendix 3	
N-T corn + soys /2	$77,434.00
C-T corn + soys /2	$135,336.00
Crop Returns Over Allocated Costs: From Table 4	
N-T corn + soys /2	$160.12
C-T corn + soys /2	$119.03
Crop Gross Returns / Fuel Cost: From Table 4	
N-T corn + soys /2 - $285.95 / $1.68 =	$170.21
C-T corn + soys /2 - $273.54 / $5.29 =	$ 51.71

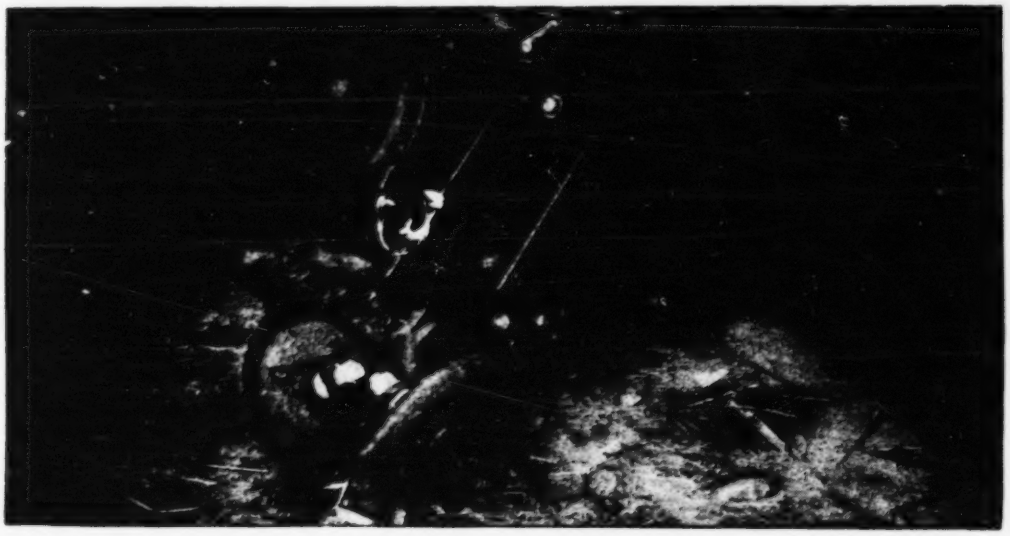
NOTE: Average values for a simple rotation of corn and soybeans (see Table 4) were used to better indicate the impact of tillage systems on cost and returns.

PLANTER SET-UP

The attachments below were common to each of the No-Till planter set-ups compared in this study.



To insure necessary planter attachment soil penetration, 75 kg of weight per row is added. Most farmers either own similar tractor weights or have access to them without cost.

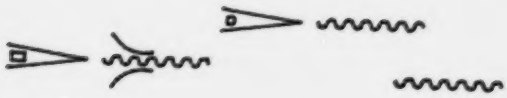


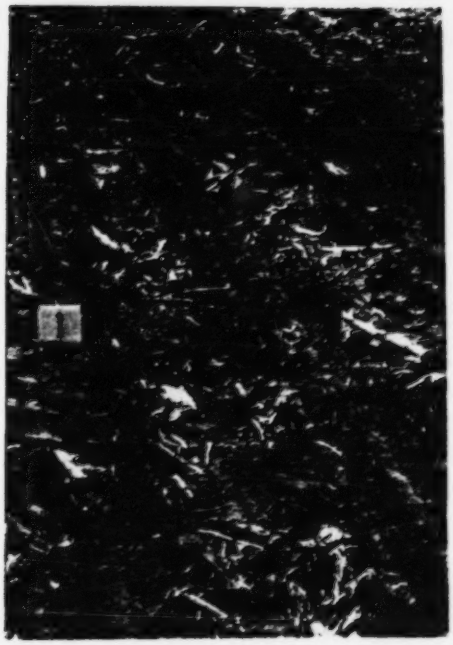
Press wheels (3) - the first wheel presses seed in the bottom of the seed trench, the following two press the seed trench closed over the seed.

This type of unit is a Conventional-Till White Farm Equipment option but works very well in the more difficult to manage No-Till soils.

SET-UP CODE (21)
($716 / row)

Basic Set-up in 1984

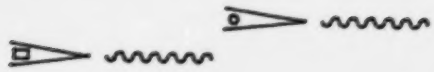




- two coulters at front loosen soil so aggressively that furrowing disks form trenches
- no residue left in the row area
- unstable soil in row area is an erosion hazard
- residue caught on the coulter arm between the front coulters and plugged
- fertilizer placement was good

SET-UP CODE (22)
($400 per row)

Enhanced Tillage Setup
- used on soy ground
in 1984, 85,and 86



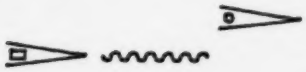
- loosening action of front coulter results in more soil movement by each planter component.

- often too much residue for corn after corn or wheat. Suitable for corn after soys or soys after any crop.

- good fertilizer placement.

SET-UP CODE (23)
($208 / row)

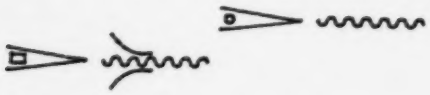
Minimum Tillage



- Very little residue removed from its row area
- some slug and phytotoxic damage to crop
- shallow fertilizer placement in hard soil

SET-UP CODE (24)
($525 / row)

Preferred set-up
in 1985, 86
(for residue)



- replaced (21) after 1984
- adequate tillage
- good fertilizer placement
- adequate residue removal
- soil movement from the row area was minimal

OVERHEAD AND MAINTENANCE COST/HR.

ITEM	CODE	REPLACEMENT COST	ANNUAL DEPRECIATION	ANNUAL HRS. USE	INVESTMENT COST -10%	REPAIRS AND LUBRICANT *	MISC. COST +	TOTAL OVERHEAD& MAINT. $/hr.
Tractors								
White 105 - 1979	(1)	40000	3000	400	1300	775	267	13.36
White 1665 - 1969	(2)	27000	2025	400	650	625	180	8.70
MF 165 - 1966	(3)	20000	1500	250	400	780	133	11.25
Combine								
White 8600 - 1977	(10)	80000	6000	225	1850	4100	533	55.48
Corn head	(11)	"						
Soy head	(12)	"						
Planter								
White 5100 - 1982	(20)	19000	1425	120	900	480	127	24.43
	(21)	23300	1748	120	1330	625	153	32.13
	(22)	21400	1605	120	1140	605	143	29.11
	(23)	20250	1519	120	1025	590	135	27.24
	(24)	22150	1661	120	1215	610	148	30.28
Seed drill								
Best Acra Plant	(31)	18500	1386	80	1200	785	123	43.68
M.B. Plow								
White 598	(40)	14000	840	100	500	450	93	18.83
White 548	(41)	8000	480	50	200	120	53	17.06
White 548 cut offs	(43)	7000	350	50	160	120	47	13.54
Cultivator								
White 5.5 m.	(51)	9000	540	130	160	290	60	8.08
Disk								
White 4.3 m.	(50)	6500	390	40	150	110	43	17.33
Packers 5.5 m.	(52)	2500	150	40	60	180	17	10.18
Sprayer 1800 L.	(60)	4500	338	100	150	380	30	8.98
Spray with drops	(61)	4700	352	100	160	390	31	9.33
Nitrogen Applic.								
Side Dress	(70)	7500	563	80	90	260	50	12.04
Fertilizer Spreader	(71)	2500	188	20	70	30	17	15.25
Row Crop Cultivator	(80)	3000	180	40	60	110	20	9.25

Notes:

\+ Misc. Cost = .00667 x Replacement Cost (Actual) = 1/3 of Agdex 825 estimate of 2%

* Average annual - based on 5 year actual

Depreciation: Tractor, Combine, Sprayer, Applicator, Planter - 75% of cost /10
Other implements - 90% of cost/15 Agdex 825, OMAF.

Assume - Crop - 400 ac.
- Custom Work - 200 ac.

EQUIPMENT - OVERHEAD AND MAINTENANCE COST/ACRE

Example: Study Site 3, 1984

CONVENTIONAL-TILL					NO-TILL				
M.B. Plow	(1) (40)	20 min.	$ 4.45 6.28	$10.73	Plant	(2) (21)	11.54 min.	1.67 6.18	7.85
Cultivate x 2	(2) (51)	6.82 min.	$ 1.52 .92 x 2	4.88	Custom Spread Fertilizer (72)				5.00
Plant	(2) (20)	11.1 min.	$ 1.62 4.52	6.14	Side Dress N.	(2) (70)	10 min.	1.45 2.01	3.46
Custom Spread Fertilizer (72)				5.00	Spray	(3) (60)	3 min.	.56 .45	1.01
Side Dress N.	(2) (70)	10 min.	$ 1.45 2.01	3.46	Spray	(3) (60)	5 min.	.94 .75	1.69
Spray	(3) (60)	3 min.	.56 .45	1.01	Spray	(3) (61)	5 min.	.94 .78	1.72
Spray	(3) (60)	5 min.	.94 .75	1.69					
Spray	(3) (61)	5 min.	.94 .78	1.72					
Total Cost/Acre				**34.63**					20.73

Note:

- numbers in brackets are equipment codes.
- use time x equipment hourly cost (Appendix 2A) = the acre cost of operation performed.

MACHINE INVESTMENT/ACRE

(Replacement Value of Equipment Used per System)

Example:

STUDY SITE 3 1984

CONVENTIONAL-TILL			NO-TILL	
Equipment (Code)	(1)	$40000	(2)	$ 27000
	(2)	27000	(3)	20000
	(3)	20000	(21)	23300
	(20)	19000	(61)	4700
	(40)	14000	(70)	7500
	(51)	9000		
	(61)	4700		
	(70)	7500		
Total Value of equipment required/Tillage system /study site		$141200		$82500

AVERAGE VALUE OF EQUIPMENT OF NEW REPLACEMENT COST - ALL SITES

Corn - 18 sites	No-Till	$82289
	Conventional-Till	138672
N-T Value is 59% of C-T		
Soys - 9 sites	No-Till	72578
	Conventional-Till	132000
N-T value is 55% of C-T		
Overall Average	No-Till	77434
	Conventional-Till	135336
N-T Value is 57% of C-T		

MACHINE INFORMATION - BASE/DATE 1986

Machine Item	Size	Age Yrs	Current VAlue	Replacm't New Cost	Data Sheet Code	Comments
Tractor						
White 105 D.	105hp	7	$13000	40000	(1)	
White 1655 D.	70	17	6500	27000	(2)	
M.F. 165 D.	52	20	4000	20000	(3)	
Combine						
White 8600 D-Grain	15'	10	14500	56000	(10)	Total replacement cost
-Corn	4 row	10	4000	12000	(11)	is $80000.
-Soys	15'	10	3500	12000	(12)	
Planter						
White 5100	6x30"	5	9000	19000	(20)	Basic Planter C-T.
			13300	23300	(21)	Added Attmt $4300-1984
			11400	21400	(22)	2400
			10250	20250	(23)	1250
			12150	22150	(24)	3150
			12550	22550	(25)	3550
				21400	(26)	2400
Plow M.B.						
White 598 Vari-Width	5 Fur	6	6500	14000	(40)	
White 548	4x18"	8	2000	8000	(41)	
White 548	4x18"	8	1600	7000	(43)	80% of M.B. cut off
Seed Drill-Best/Acra	15'	3	13000	18500	(31)	No-Till Drill
Plant						
Disk Harrow -White	14'	10	1500	6500	(50)	
Field Cultivator -White	18'	8	1600	9000	(51)	
Land Packer -Turnco	18'	12	600	2500	(52)	
Crop Sprayer	30'	1	1500	4500	(60)	
Crop Sprayer			1600	4700	(61)	with drop nozzles
Fertilizer Applicator	500gal.	8	900	7500	(70)	Side Dress U.A.N.
Fertilizer Spreader	2 T.	11	700	2500	(71)	Dry Fertilizer
Row Crop Cultivator	6 row.	11	600	3000	(80)	
Fertilizer Custom Spread @ Custom Charge $4.00 - 5.00/ac.					(72)	Air Boom-Dry.

MACHINERY PERFORMANCE

Activity	Machine Codes	Revalent Information	1984 gal/ac	1984 ac/hr.	1985 gal/ac	1985 ac/hr	1986 gal/ac	1986 ac/hr
Plow- M.B.	40 + 1	Sod	1.24	2.5				
		Grain stubble + clover	1.1	3.0				
		Soy stubble	1.1	3.0				
		Corn stover	1.15	2.8				
	41 + 1	Grain stubble + clover-7"deep			1.2	2.6	1.26	2.4
		Soy stubble 7" deep			1.2	2.62	1.21	2.55
		Corn stover 7" deep			1.35	2.6	1.36	2.4
		Corn stover after NTcorn 7"					1.19	2.55
	43 + 1	Corn stover 6"			1.25	2.7	1.23	2.6
Chisel Plow	45 + 1	Wheat stubble 6"			.82	5.1		
Disk	50 + 1	Conv.Till in spring 4"	.51	6.2	.51	6.2	.51	6.2
	50 + 52 + 1	Conv.Till in spring 4"	.58	6.0	.58	6.0	.58	6.0
	50 + 2	Corn stover in fall 2"	.32	6.0	.32	6.0		
	50 + 1	Soy stubble in spring 4"			.55	5.9		
Cultivate	51 + 1	Conv. Till in spring 4"	.36	8.8	.36	8.8	.37	8.5
	51 + 52 + 1	Conv. Till in spring 4"	.42	8.1	.42	8.1	.42	8.0
	51 + 1	Primary Till in spring 4"					.55	7.2
Crop Spray	60 + 3	7 U.S. gal/ac.	.07	30	.07	30	.07	30
		12	.08	20	.08	20	.08	20
		18	.125	12	.125	12	.125	12
		26	.18	8.3	.18	8.3	.18	8.3
		32	.32	6.75	.32	6.75	.32	6.75
Plant	20 + 2	Conv. Till	.39	5.4	.39	5.4	.39	5.4
		Conv. Till, Min Till-No Fert.	.35	5.7	.35	5.7		
	21, 24 + 2	N.T.	.41	5.2	.44	5.0	.44	5.0
		N.T., No Fertilizer	.4	5.2	.43	5.1		
	22, 23 + 2	N.T.	.41	5.2	.41	5.2	.41	5.2
		N.T., No Fertilizer	.4	5.2	.4	5.2		
Seed Drill	31 + 2	N.T. drill with 'caddy'	.39	5.5	.39	5.5		
	31 + 52 + 2	Conv.Till-drill & cult. attch. and packer	.47	5.2				
	30 + 1	N.T. drill, -on tractor 3 p.h.	.41	5.7				
	31 + 2	Conv. Till drill with 'caddy'			.44	5.3		
	31 + 1	Conv. Till drill with 'caddy'			.45	5.7		
	31 + 52 + 1	Conv. Till drill with 'caddy' and packer			.48	5.6		
Side Dress N.	70 + 2		.3	6.0	.3	6.0	.3	6.0
Spread Fert.	71 + 3		.1	20	.1	20	.1	20
Spread Fert.	72	Custom Applicator	.12	65	.12	65	.12	65
Row Cultivate	80 + 2				.32	6.0		
Combine	12	N.T. soys	.79	3.8	.79	3.8	.8	3.8
		Conv. Till Soys	.79	3.8	.79	3.8	.87	3.4
	11	N.T. corn	1.06	3.2	1.06	3.2	1.08	3.2
		Conv. Till corn	1.06	3.2	1.18	3.0	1.26	2.8

Calculations: - based on TIME and FUEL used from the time the equipment left the fuel pump, performed the full field operation (more than 20 ac.) and then was refuelled at the pump.

CROP INPUT COSTS

INPUT	1984	1985	1986
Brazer	$23.50/L.		
Basagran	25.25/L.	26.00/L.	26.36/L
Assist	1.89/L.	1.90/L.	1.84/L.
Poast	29.95/L.	29.50/L.	
Gramoxone	14.47/L.		14.84/L.
Banvel	16.50/L.	17.50/L.	17.41/L.
2,4-D amine	2.80/L.	3.00/L.	2.80/L.
2,4-D ester			5.99/L.
Excell			15.00/L.
Dual			16.80/L.
Roundup	25.00/L	25.00/L	24.74/L.
Atrazine 90W.	2.50/lb.	2.39/lb.	2.45/lb.
Lorox	15.30/L.	15.30/L.	17.58/L.
Lasso	6.20/L.	6.60/L.	
Sencore	36.85/L.		
MCPA	3.83/L.	2.95/L.	
Corn Oil		.98/L.	
Corn Oil Concentrate	1.48/L.	1.78/L.	1.47/L.
Agral 90		8.40/L.	8.15/L.
H_2SO_4			2.85/L.
Afolon		16.70/L.	
Sprayer Marker Paint	17.00/qt.	13.00/qt.	13.00/qt.
Counter	1.42/lb.	3.75/kg.	3.68/kg.
Soy Inoculant Peat	1.00/ac unit	1.20/ac unit	1.20/ac unit
Granular		1.45/lb.	
28-0-0 (U.A.N.)	180.00/t	196.00/t	164.00/t
34-0-0	242.00/t	233.00/t	
0-0-62	176.00/t	161.00/t	137.00/t
0-46-0		275.00/t	
12-40-6	365.00/t	323.00/t	292.00/t
9-23-30	268.00/t	238.00/t	
4-29-29	250.00/t		
12-28-14		264.00/t	
0-26-26		217.00/t	
6-24-30			230.00/t
Soy Seed -0877	19.85/25 kg.		15.11/25 kg.
1282	19.85/25 kg.	16.15/25 kg.	
Evans		9.80/bu.	
Prestige	16.50/25 kg.		
Corn Seed - 3906	79.20/80000	76.00/80000	80.41/80000
3975A	76.80/80000	81.00/80000	64.24/80000
3881			
Barley Seed	10.50/25 kg.	8.47/25 kg.	
Wheat Seed	8.00/25 kg.	6.00/bu.	
Clover Seed	1.50/lb.		
Diesel Fuel	34.7¢/L.	36.9¢/L.	32.5¢/L.
Land Rent	75.00/ac.	75.00/ac	75.00/ac
Land Ownership Cost	57.00/ac	57.00/ac	57.00/ac
Topsoil Value	1.50/t	1.50/t	1.50/t

ECONOMIC DATA SUMMARY / ACRE - CORN

Site No.+ Treatment	Time Hours	Machine Invstmt	Machine Ovrhd Maint.	Fuel Cost	Fuel Litres	Seed Cost	Fert. Cost	Other Chem.Cost	Herbcd Cost	Crop Yield	Soil Loss/t
84-3 NT	.59	29000	20.73	1.83	5.27	24.94	78.60	14.31	25.11	148.4	1.61
CT	1.15	47800	34.63	4.67	13.45	24.94	78.60	14.31	22.23	147.8	8.05
7E. NT	.61	29000	21.07	1.89	5.45	26.40	83.09	14.31	25.61	133.0	2.15
CT	1.04	47800	32.19	4.10	11.82	26.40	83.09	14.31	22.23	133.5	4.08
7W NT	.61	29000	21.07	1.89	5.45	26.40	83.09	14.31	25.61	140.8	2.15
CT	1.04	47800	32.19	4.10	11.82	26.40	83.09	14.31	22.23	135.8	4.08
7A. NT	.6	29000	20.73	1.83	5.27	26.40	83.09	14.31	25.11	146.4	.82
CT	1.15	47800	34.63	4.67	13.45	26.40	83.09	14.31	22.23	146.1	3.60
8 NT	.56	29000	19.92	1.74	5.00	24.94	80.30	14.31	18.48	134.4	1.27
CT	1.12	47800	34.39	4.62	13.32	24.94	80.30	14.31	17.23	132.0	5.25
10 NT	.61	29000	21.08	1.92	5.54	26.40	83.09	14.31	32.65	179.4	.23
CT	1.2	47800	36.44	4.88	14.05	26.40	83.09	14.31	28.48	167.3	1.04
85-3 NT	.58	27850	20.35	1.98	5.36	27.34	76.48	15.34	18.37	121.3	1.07
CT	1.14	43200	34.55	5.25	14.23	27.34	76.48	15.34	16.87	121.4	5.64
5 NT	.58	27850	20.35	2.15	5.82	25.65	76.48	15.34	19.53	129.3	2.53
CT	1.14	42300	34.55	5.25	14.23	25.65	76.48	15.34	16.87	128.7	14.45
7W NT	.58	27850	20.35	1.98	5.36	25.65	76.48	15.34	17.40	130.6	.89
CT	1.03	42300	32.11	4.65	12.59	25.65	76.48	15.34	16.40	124.4	4.66
7E NT	.58	27850	20.35	1.98	5.36	25.65	76.48	15.34	17.40	118.5	.89
CT	1.03	42300	32.11	4.65	12.59	25.65	76.48	15.34	16.40	126.3	4.66
7A NT	.58	27850	20.35	1.98	5.36	25.65	76.48	15.34	17.40	114.5	2.26
CT*	1.29	43400	37.80	5.94	16.09	25.65	76.48	15.34	16.40	109.7	4.11
7Aa. NT	.58	27850	20.35	1.98	5.36	25.65	76.48	15.34	17.40	117.6	2.26
CT*	1.29	43400	37.80	5.94	16.09	25.65	76.48	15.34	16.40	117.5	4.11
12 NT	.63	27850	21.36	2.07	5.61	25.65	74.65	Ø	18.83	146.2	1.17
CT	1.23	42300	36.19	5.21	14.12	25/65	74.65	Ø	16.44	146.3	2.33
19 NT	.63	27850	21.36	2.07	5.61	27.34	69.18	Ø	22.29	134.4	6.16
CT	1.23	42300	36.19	5.21	14.12	27.34	69.18	Ø	21.29	128.2	9.48
86-16a NT	.62	25650	16.80	1.72	5.30	21.68	60.13	15.03	18.33	100.7	Ø
CT	1.22	39300	32.09	4.64	14.27	21.68	60.13	15.03	17.08	99.2	Ø
16b NT	.62	25650	16.80	1.72	5.30	21.68	60.13	15.03	18.33	106.5	Ø
CT	1.20	39300	32.09	4.39	13.50	21.68	60.13	15.03	17.08	111.5	Ø
18 NT	.58	25850	15.99	1.61	4.96	27.14	61.77	15.03	16.59	119.0	Ø
CT*	1.39	40400	39.64	5.41	16.64	27.14	61.77	15.03	16.59	122.0	Ø
20 NT	.62	25650	16.80	1.72	5.30	21.68	60.13	15.03	18.33	112.0	Ø
CT	1.22	39300	32.09	4.64	14.27	21.68	60.13	15.03	17.08	105.0	Ø
Average NT	.61	27756	19.77	1.92	5.37	25.34	74.23	12.23	20.71	129.6	1.82
18 sites CT	1.17	43700	34.54	5.20	14.51	25.34	74.23	12.23	18.86	127.9	5.4
NT as a % of CT	52%	64%	57%	39%					110%	101%	34%

NT = No-Till
CT = Conventional-Till
* Cut-off mouldboards

ECONOMIC DATA SUMMARY / ACRE - SOYS

Site No.+ Treatment		Time Hours	Machine Invstmt	Machine Ovrhd Maint.	Fuel Cost	Fuel Litres	Seed Cost	Fert. Cost	Other Chem.Cost	Herbcd Cost	Crop Yield	Soil Loss/t
84-11	NT	.57	26100	14.59	1.66	4.77	22.38	29.79	2.00	46.15	26.7	3.11
	CT	1.25	47400	40.18	5.36	15.46	22.38	29.79	2.00	53.39	28.9	19.10
12a	NT	.43	29700	19.21	1.51	4.34	34.29	27.36	ø	41.10	46.13	.23
	CT	1.13	54900	42.81	4.79	13.80	34.29	27.36	ø	64.00	40.15	1.04
12b	NT	.61	26100	16.96	1.52	4.39	22.38	27.36	ø	51.10	40.2	.23
	CT	1.11	46800	36.60	4.60	13.25	22.38	27.36	ø	64.00	36.4	1.04
85-8	NT	.33	26100	14.75	1.26	3.42	19.09	39.27	ø	28.73	43.5	1.2
	CT	1.19	42500	37.72	5.88	15.93	19.09	39.27	ø	32.56	38.6	6.23
86-1a	NT	.36	23400	10.56	1.05	3.11	17.03	19.83	1.00	31.36	39.6	ø
	CT	1.19	38200	32.45	4.81	14.80	17.03	19.83	1.00	47.79	35.8	ø
1b	NT	.36	23400	10.56	1.05	3.11	17.03	19.83	1.00	31.36	35.3	ø
	CT	1.19	38200	32.45	4.81	14.80	17.03	19.83	1.00	47.79	35.8	ø
1As	NT	.56	23400	17.81	1.70	4.98	22.66	19.83	1.50	31.36	38.2	ø
	CT	1.38	38200	38.58	5.39	16.57	22.66	19.83	1.50	47.79	29.7	ø
1Ab	NT	.56	23400	17.81	1.70	4.98	22.66	19.83	1.50	31.36	31.2	ø
	CT	1.38	38200	38.58	5.39	16.57	22.66	19.83	1.50	47.79	29.7	ø
3	NT	.32	23400	9.77	.94	2.77	17.03	19.83	1.00	31.98	42.4	ø
	CT	1.04	38200	29.45	4.48	13.80	17.03	19.83	1.00	27.50	39.6	ø
Average 9 sites	NT	.46	25000	14.67	1.43	3.99	21.62	24.77	.89	36.06	38.13	1.19
	CT	1.21	42511	36.54	5.37	15.00	21.62	24.77	.89	48.07	34.96	6.85
NT as a % of CT		38%	59%	40%	27%	27%				75%	109%	17%

NT = No-Till
CT = Conventional-Till